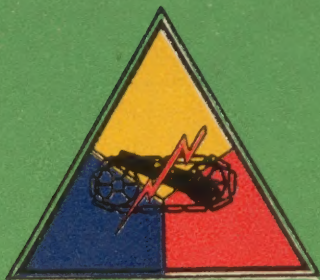


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ARMORED MEDICAL RESEARCH LABORATORY

FORT KNOX, KENTUCKY

INDEXED

PROJECT NO. 7 - NIGHT VISION FROM TANKS

Report On

Sub-Project No. 7-2, Determination of Intensity, Distribution and
Type of Illumination in Tanks Least Disturbing
to Dark Adaptation

Sub-Project No. 7-3, Investigation of Methods of Improving Night
Vision in Tank Crews by the Use of Eye
Appliances

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INTERIOR LIGHTING OF M4 TANKS

Project No. 7-2, 7-3

INFORMATION COPY

February 25, 1943

ARMORED FORCE MEDICAL RESEARCH LABORATORY
Fort Knox, Kentucky

Project No. 7-2, 7-3
File No. 741

February 25, 1943

INTERIOR LIGHTING OF M4 TANKS

1. PROJECT: No. 7, Night Vision from Tanks. Sub-project No. 7-2, Determination of Intensity, Distribution and Type of Illumination in Tanks Least Disturbing to Dark Adaptation. Sub-project No. 7-3, Investigation of Methods of Improving Night Vision in Tank Crews by the Use of Eye Appliances.

a. Authority: Letter Commanding General, Headquarters Armored Force, Fort Knox, Kentucky, File 400.112/6 GNOHD, dated September 21, 1942.

b. Purpose: To adapt controlled white and red lighting, for day and night use, to the M4 tank.

2. DISCUSSION: The advantages of red light as a means of preserving dark adaptation for night tank operations have been discussed in a previous report under project 7-2. The illumination required for daylight operation (10 foot candles or less) in closed tanks is considerably in excess of that necessary for night operations (1 foot candle and less) and red light offers no advantages under these conditions. Furthermore, the electrical energy required for producing red light of a given brightness is much more than that required for white light of equal brightness. A dual lighting system is therefore needed to provide white light during the day and red light of lower intensity at night.

This report deals with the problems of fixture design, location of lights, light distribution, intensity and the controls necessary for both types of illumination.

3. CONCLUSIONS:

a. Adequate red light illumination for night use is provided by one 6-candle power bulb per fixture coated with a suitable red filter when mounted in the present fixture.

b. White light of the required intensity for normal daylight use is provided by one 6-candle power bulb in each fixture.

1. The purpose of this document is to provide information to the public regarding the activities of the Department of the Interior, Bureau of Land Management, in the area of public lands management. This document is intended to be a general overview of the Bureau's activities and is not intended to be a detailed report of the Bureau's activities.

2. Introduction

The Bureau of Land Management is a part of the Department of the Interior. The Bureau is responsible for managing the public lands of the United States. The Bureau's activities are divided into three main areas: land management, resource management, and planning and development.

The Bureau's land management activities include the acquisition, management, and disposal of public lands. The Bureau's resource management activities include the management of the Bureau's natural resources, including fish and wildlife, and the management of the Bureau's cultural resources. The Bureau's planning and development activities include the development of land use plans and the management of the Bureau's public lands.

The Bureau's activities are carried out through a network of field offices and regional offices. The Bureau's field offices are located in all 50 States and the District of Columbia. The Bureau's regional offices are located in the four major regions of the United States.

The Bureau's activities are carried out in accordance with the laws and regulations of the United States. The Bureau's activities are also carried out in accordance with the policies and directives of the Department of the Interior.

The Bureau's activities are carried out in a manner that is consistent with the public interest. The Bureau's activities are also carried out in a manner that is consistent with the principles of public land management.

3. Land Management

The Bureau's land management activities include the acquisition, management, and disposal of public lands. The Bureau's land management activities are carried out in accordance with the laws and regulations of the United States.

c. After exposure to extreme glare (reflection from snow or white sand, for example, on a bright day), illumination of a higher order may be required for difficult tasks. This will necessitate the use of auxiliary lights.

d. Three dual lighting fixtures are required in the turret, two in the bow and one in the starboard sponson.

e. The present light fixture can be modified to permit the installation of both the red and white lights.

f. Proper control of brightness for both lights can be obtained with rheostats.

4. RECOMMENDATIONS:

a. That the dual lighting and controls described in the appendix be installed in M4 tanks, —three fixtures in the turret, two in the bow and one in the starboard sponson.

b. That instructions regarding the proper use of red light for preserving dark adaptation be given to all tank crew members and that night training with the lights be made a part of the advanced training program.

c. That the following additional aids to night vision be incorporated in the M4 tank: (1) Lettering that must be read at low light intensities should be block type, white on black letter at least one inch in height, line width 1/4 inch. (2) All knobs, controls, etc. to be painted white. (3) Instrument panels be redesigned and relocated for better day and night use. (4) Maps for night use to be printed boldly black on white or tonal keyed. Maps with red printing are unsuited for use with red light unless tonal keyed. (See Appendix III)

d. That one-half of the regular complement of flashlights be fitted with red filter material.

e. That all light fixtures be installed "spring-loaded" to protect against failure when the tank is hit.

f. That the reflectors of fixtures be carefully painted with a white, high red-reflecting paint such titanium oxide paint.

g. That all switches be capable of withstanding severe vibration.

h. That the trouble-light connections be retained adjacent to commander's light and on the instrument panel.

i. That auxiliary lighting for map and instrument panel reading after exposure to glare of the order 10,000 foot candles (sun on desert or snow) be provided by 32-candle power bulbs to be used in the emergency (trouble) light.

1. The first part of the report is devoted to a general survey of the situation in the country. It is based on the information received from the various sources and is intended to give a general impression of the state of affairs.

2. The second part of the report is devoted to a detailed examination of the various aspects of the situation. It is based on the information received from the various sources and is intended to give a detailed account of the state of affairs.

3. The third part of the report is devoted to a summary of the findings of the investigation. It is based on the information received from the various sources and is intended to give a summary of the state of affairs.

4. The fourth part of the report is devoted to a summary of the conclusions of the investigation. It is based on the information received from the various sources and is intended to give a summary of the state of affairs.

5. The fifth part of the report is devoted to a summary of the recommendations of the investigation. It is based on the information received from the various sources and is intended to give a summary of the state of affairs.

6. The sixth part of the report is devoted to a summary of the conclusions of the investigation. It is based on the information received from the various sources and is intended to give a summary of the state of affairs.

7. The seventh part of the report is devoted to a summary of the conclusions of the investigation. It is based on the information received from the various sources and is intended to give a summary of the state of affairs.

8. **CONCLUSIONS**

9. The eighth part of the report is devoted to a summary of the conclusions of the investigation. It is based on the information received from the various sources and is intended to give a summary of the state of affairs.

10. The ninth part of the report is devoted to a summary of the conclusions of the investigation. It is based on the information received from the various sources and is intended to give a summary of the state of affairs.

11. The tenth part of the report is devoted to a summary of the conclusions of the investigation. It is based on the information received from the various sources and is intended to give a summary of the state of affairs.

Submitted by:
Captain Lester B. Roberts, Sn-C

APPROVED Willard Machle
WILLARD MACHLE,
Lieutenant Colonel, Medical Corps,
Commanding.

6 Incls.
Appendices I, II, III
Figures 1, 1a, 2

12th St. N. W.
Washington, D. C.
April 10, 1907

My dear Mr. [Name]
I have your letter of the 4th inst.
and am glad to hear that you are
interested in the [Project]

Very truly yours,
[Signature]

APPENDIX I

Procedure:

Lights were tested in the laboratory and in a tank. Measurements were made of brightness and the amount of illumination supplied by individual fixtures and combinations of fixtures. Tasks within the tank were carried out and the lighting adjusted to provide adequate illumination after exposure to outside light.

APPENDIX II

For this study, red filter material (designated as 8 AP and meeting specifications for dark adaptation goggle lenses) was used over the white light as the red light source. It was found subsequently, however, that the bulbs can be successfully coated with this material, which makes the use of the filter unnecessary and allows both the red and white light bulbs to be mounted in the same fixture. Light transmission tests on bulbs coated with the material are being carried out. Fig. A shows a suggested schematic wiring diagram for the dual lighting system. Any variations can be made so long as the principle is retained. A 3-position switch (red, off and white) is provided on each fixture. Two master rheostats, one for the commander and one for the driver, control the brightness of both the red and white lights in the turret and bow respectively. A red-white switch on the rheostat control board makes it possible to control the light to be used. Red light is always available (except when master battery switch is turned off) but the white lights can be turned on in the turret only when the commander's rheostat switch is on white and in the bow when the driver's rheostat switch is on white. This limits the control of the white light and the brightness of either red or white light to these two men and safeguards against white light being used when it would interfere with dark adaptation or reveal the position of the tank. Fixture locations are indicated in Fig. B.

The illumination at a distance of one foot from the red light is about 1.2 foot candles; the white light at the same distance provides about 10 foot candles. An illumination of 10 foot candles with white light is sufficient to read detailed maps after exposure to glare of approximately 6000 foot candles (strong sunlight on roads). Extreme brightness of sun on snow is approximately 10,000 foot candles. The illumination necessary for detailed map reading after exposure to this intense glare would require extremely high candle power lights in larger fixtures and excessive power consumption. This, however, is an unusual condition which can be met by the use of the trouble light. It is recommended therefore that 32 candle power bulbs be carried for use in the trouble light for operations in the desert or on snow.

Bright light (red or white) is supplied for map reading, machine gun clearing, and gun adjustments (elevation wheel or 75 mm gun). The

1000
1000

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1000

1000
1000

1000

1000
1000

corresponding light sources have been located so as to supply an adequate flood of light throughout the tank with the exception of a few seldom used places where lighting with fixtures is impractical. The use of flashlights in these locations can be continued.

APPENDIX III

If production limitations prevent the immediate procurement of tonal keyed maps, conventional maps may be used if the red lines are drawn over with ink or black crayon. Maps for night use should be procured as soon as possible. Production of maps for night use is under development by the Army Map Service.

THIS LIGHT TO BE
REMOVED

LIGHT TO BE MOUNTED ON INNER
SIDE TOP SPONSON

LIGHT TO BE MOUNTED BETWEEN
TWO INTERPHONE BOXES. MOUNT
AND LIGHT TO BE HIDDEN BE-
TWEEN PHONE BOXES AND
LIGHT TO BE AT A 50° ANGLE.
MOUNT TO CONTAIN RHEOSTAT

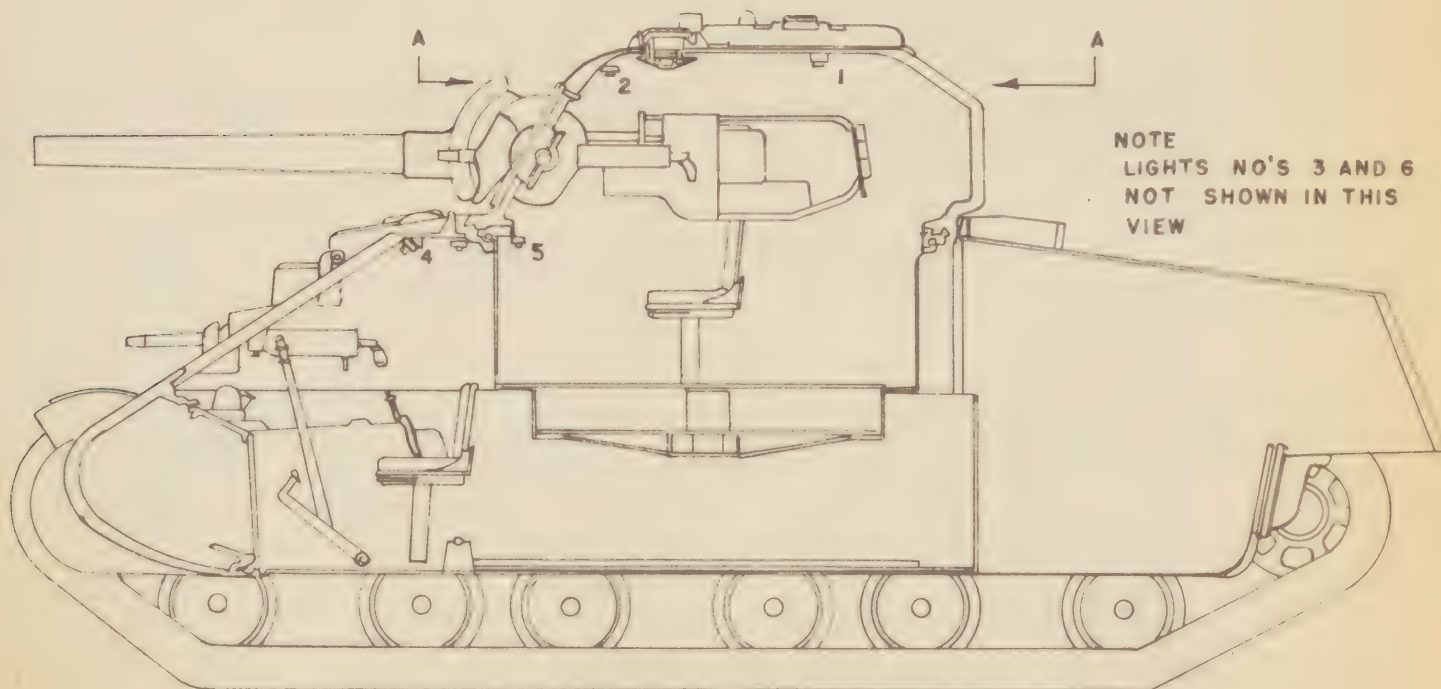
LIGHT TO BE MOUNTED
LEVEL WITH FLOOR LINE
ON TURRET ROOF

LIGHT TO BE MOUNTED
ON TURRET ROOF-FLUSH

THIS LIGHT TO
REMAIN

LIGHT NUMBERS

- | | |
|--------------------------|------------------------|
| 1 TANK COMMANDER'S LIGHT | 4 ASS'T DRIVER'S LIGHT |
| 2 GUNNER'S LIGHT | 5 RT. SPONSON LIGHT |
| 3 LOADER'S LIGHT | 6 DRIVER'S LIGHT |



LOCATIONS FOR DUEL RED AND WHITE LIGHTS FOR
M4 TANK

FIG. 1

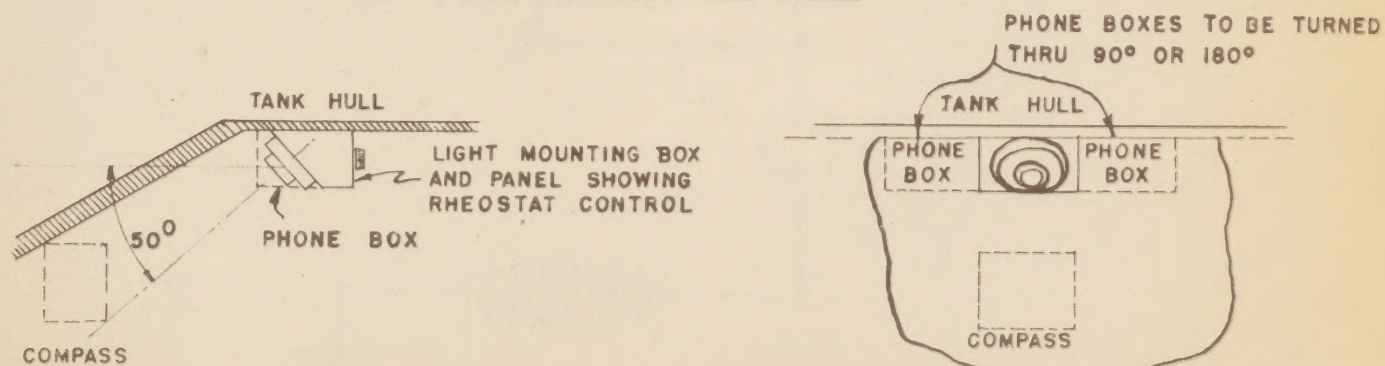
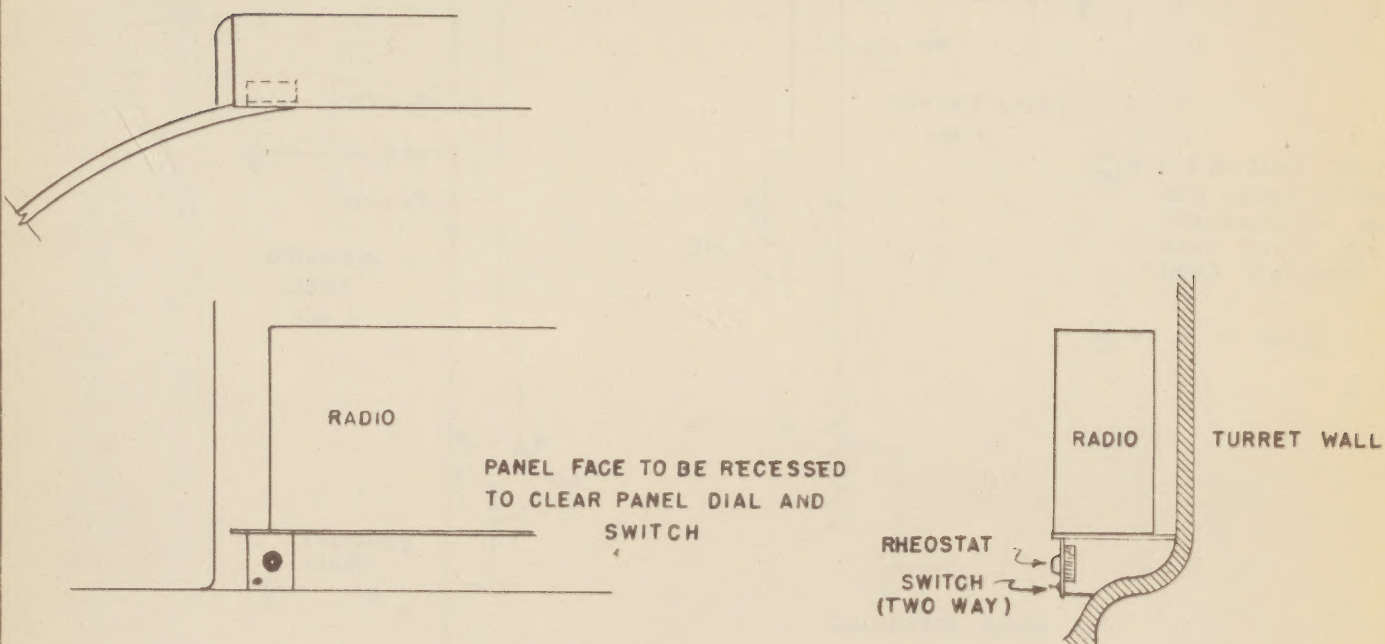
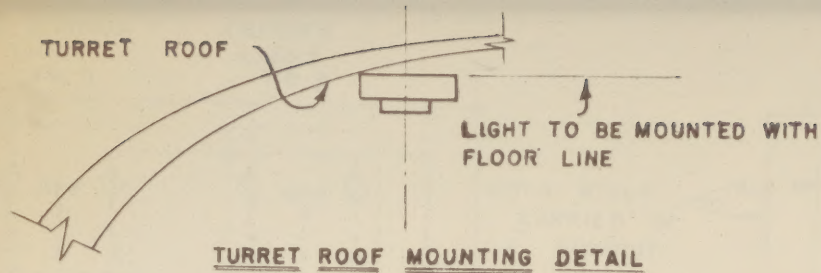


FIG. 1A

THESE ARE THE ONLY TWO PLACES WHERE THE



THESE ARE THE ONLY TWO PLACES WHERE THE



THESE ARE THE ONLY TWO PLACES WHERE THE

THESE ARE THE ONLY TWO PLACES WHERE THE

